Trade Link, Neighbourhood and Country Size: Which is More Important in Driving Contagion?

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Abstract

In this study, the relative importance of three preselected contagion channels has been tested, namely, trade link, neighbourhood effects and country size in transmitting the financial crises. Contagion is defined as the co-movements between financial markets during crises periods after eliminating the common shock impact. Major stock market indices returns have been employed from 21 countries during the 1997 Asian crisis, 1998 Russian Crisis, 1999 Brazilian Crisis and 2008 American Crisis as the contagion effect indicator, and weighting matrices have been built for each contagion channel to reflect the inter-country relationship regarding this specific contagion channel. The results show that the co-movements in our sample countries are caused by contagion effect rather than common shocks. All three contagion channels are statistically significant in explaining the contagion effect during the four crises, while the neighbourhood effect is the dominant driver. Moreover, the results across different financial crises are very consistent.

Keywords

Contagion; Stock Market; Financial Crisis; Trade, Neighbourhood Effects

Introduction

Compared with the previous financial crisis, whose impacts were relatively regional, the most recent 2008 financial crisis originated in the US has spread rapidly to almost all regions of the world and has had a huge impact on the global economy. As US plays the most important role in the global economy, it is not surprising that when it crashes, other economies also crash as in a dominos game. Before the 2008 American crisis, a series of other regional crises have taken place, which tended to have different initial causes, originating in countries with very different economies. With such differences in their origins, how do these crises spread? Appendix A provides a brief overview of the major stock market performance worldwide during four crises periods; the 1997 Asian crisis, the 1998 Russian crisis, the 1999 Brazilian crisis, and the 2008 American crisis. From the graph in Appendix A, it can be seen that, for the 2008 crisis, all the major stock indices declined sharply. In the case of the other three crises, however, other than in the originating country, not all indices were affected, and the impacts, if they existed at all, differed among economies. This phenomenon is the focus of this research: that is, the drives of the difference.

While many researchers focus on testing the existence of contagion and its magnitude, this research puts the emphasis on the fact that different countries suffer different degrees based on the contagion spread. The objective of this paper is to reveal the reason or key driver of the differences and meanwhile, to examine whether the driver is the same for different crises.Previous researchers address different meanings of the term contagion. Some start with the most straightforward method and define contagion as the movement of financial markets during crisis period. For example, Kaminsky and Reinhart (2000) examine the correlation of stock index returns during the 1994 Mexican crisis, the 1997 Asian crisis, and the 1998 Russian crisis. Their study strongly suggests the existence of contagion, although different contagion channels could explain different crisis. Similar definition of contagion can be found in Eichengreen and Portes (1997), Hernandez and Valdes (2001) and de Gregorio and Valdes (2001) discover contagion worldwide.

Forbes and Rigobon (2002), however, define contagion as a significant increase in cross-market linkages after a shock to a country, or a group of countries and believe that prior testing discovering correlation between markets tends to be biased due to heteroskedasticity. The paper suggests that rather than

contagion existing only during crisis period, there is a strong long term interdependence between markets.

Bekaert et al. (2005) define contagion as the excess correlation over and above what one would expect on economic fundamentals. After controlling over the global, regional, and country-specific fundamentals, as well as the mechanism that transfers fundamentals into correlations, they find no evidence of contagion for the Mexican crisis. However, they do find significant evidence to support the existence of contagion during the Asian crisis.

According to de Gregorio and Valdes (2001), a contagion can be simply defined as country A getting into trouble as a consequence of country B falling into difficulty. One noticeable point is that this should exclude the effect of common shocks. More clearly, the term trouble means, in this instance, the associated devaluation, breakdown, or depreciation that accompanies a financial crisis. Calvo and Reinhart (1996) present detailed research to separate out the true contagion we should focus on after all common shocks and inter-linkages between contagions channels are controlled for. Rigobon (1999) also emphasizes this issue. In this study, we follow the definition of contagion used by de Gregorio and Valdes (2001)it is referred to as the co-movement suffered by countries during crisis periods that are unexplained by initial conditions, or common shocks.

Previous papers have developed a number of techniques to measure contagion; most of which measure the contagion by testing the correlation of the excess volatility on financial market returns (see for example, Bekaert et al., 2005; Forbes and Rigobon, 2002). According to Dungey et al. (2005) who review a number of existing studies on contagion, there are five main types of models used in the literatures to test contagion: (i) Based on reactions to unexpected shocks, or news; (ii) based on correlation analysis; (iii) probability tests; (iv) extreme returns tests; and (v) other tests. Usage of models and methods, choice of sample period and data frequency, as well as ways to deal with missing values and time zone issues contribute to the difference in findings of various studies.

After the identification made on the contagion, recent literature draws more attention to identify the transmission channels that spread crises, and the reason for that different countries may suffer from contagion to a different degree when crises originate in the same country. Chancharoenchai and Dibooglu (2006) discuss the volatility spillovers and contagion in stock markets during the Asian crisis confirm the contagion among six Southeast Asian countries and districts [1], as well as the interdependence in volatility between emerging markets and developed markets before and after the Asian crisis. De Gregorio and Valdes (2001) use bilateral trade, competition in third markets, regional relations, and indices of similarities as the transmission of contagion channels in their examination of the contagion effect during the 1982 debt crisis, the 1994 Mexican devaluation, and the 1997 Asian crisis.; then find a strong neighbourhood effect, with trade links and similarities in pre-crisis growth, also explains, to a lesser extent, which country suffers more contagion. Boyer et al. (2006) find evidence showing that crises spread through the asset holdings of international investors. Using the 1997 Asian crisis as their sample, they find a higher correlation of accessible stocks than inaccessible stocks with the crisis country's stock index returns, then conclude that crises are investor by investor: The Asian crisis spread to emerging countries by asymmetric market frictions, such as wealth constraints, and to developed countries by symmetric market frictions, such as portfolio rebalancing.

In this research, we use the co-movement in stock market returns during the crisis periods as the indicator of a contagion effect. We then determine that the key drivers of such a contagion effect is examined by trade links, the neighbourhood effect, and country size. These factors are chosen carefully upon reviewing a number of existing literatures. This research is limited to these three channels. However, there will surely be other factors driving contagion, such as economic conditions before the crisis and some crisis-specific factors. Rather than examining only the most recent crisis of 2008, the other three financial crises already mentioned will also be investigated (the 1997 Asian crisis, the 1998 Russian crisis, and the 1999 Brazilian crisis) for comparison in order to check whether the contagion exists all the time. These four crises are selected to study as they take place independently in different geographic regions during different time periods. The varying economic conditions and wide data coverage ensure a more precise analysis.

We include 21 countries from 4 regions in our sample are Asia, Russian and Eastern Europe, America, and Western Europe (Euro area). Following Hernandez

[1]The six Southeast Asian countries and districts are: Thailand, the Philippines, Indonesia, Malaysia, South Korea, and Taiwan.

and Valdes (2001), we use weekly stock market indices for three-month periods for each crisis, and construct weighting matrices to reflect the varying conditions of three contagion channels across different countries. For each crisis, univariant test is conducted to evaluate the explanatory power of each single contagion channel. The results show that all channels included in this study contribute to all the four crises we study, and the effects are all statistically significant. When two contagion channels simultaneously are involved in one regression, it is discovered that the neighbourhood effect stands out as the most important contagion channel and such pattern is consistently found across all four crises. Also, by eliminating the impact of common shock, it is proven that our results are relevant and reliable.

The main contribution of this research is that, rather than using accurate but complex models that try to quantify the contagion effect after each crisis has occurred, a simple but more straightforward method has been used to identify which is the most important factor. Through identifying this factor, more targeted prevention measures can be taken before a crisis occurs and, even if a financial crisis has already occurred due to the contagion effect, it is also useful to know that which factor should be taken into control first. Each crisis is different. By carrying out analysis to compare the cross-crisis variations due to the dramatically changing financial environment, we attempt to provide a general overview of the common facts they share. This commonality can then be used for any financial crisis, regardless of their economic differences. In an increasingly integrated financial world, it is more and more important to control the contagion effect.

The rest of this study is organised as follows: Section 2 first discusses the reasons for the selection of trade links, the neighbourhood effect, and country size as the contagion channels, then it describes the data of the study, as well as the description of the methodology and the formation of the weighting matrices; next, Section 3 analyses the empirical results; and a conclusion is made in Section 4.

Data and Methodology

Contagion Channels

The existing literature provides powerful analysis on how financial crises spread, and suggest a number of relevant transmission channels for contagion effects. In this study, what the explanatory transmission channels of a particular crisis is excluded from our interest due to the complex causes ofa financial crisisbut the importance of the preselected contagion channels; trade links, neighbourhood effects, and country size; for a particular financial crisis. This means that, for a particular crisis, all of these three transmission channels may be simultaneously relevant. In this study, we will determine the dominant channel.

As mentioned in many existing studies, each financial crisis may result from different reasons. For example, the 2008 American crisis started with the credit collapse in housing markets, the 1997 Asian crisis began with the huge depreciation of the Thai baht after the Thai government's decision to let the exchange rate float, and the 1998 Russian crisis is claimed to be a consequence of the 1997 crisis. The outcomes are, however, always similar with fluctuating currency markets, stock market collapses, and the failure of key businesses, etc. In this research, the crisis-specific factors is not the focus, such as bank lending for the 2008 crisis, as this may be extremely important for one crisis and of no account for other crises. Thus, the results would be less persuasive.

Through study on a number of previous works, transmission channels of trade, neighbourhood effects, and country size are selected for this studydue to their characteristics as the most general contagion channels which have been determined to be relevant for the four crises to be tested here. By choosing these channels carefully, we could eliminate the crisis-specific factors, so that comparison across different crises is valid. These three contagion channels are briefly outlined as follows:

1) Trade Link

Trade link discussed broadly in regards to its power in transmitting contagion, is normally considered to have a negative impact on financial indicators. Recently, however, researchers pay more attention to its mixed impact rather than solely examining its negative impact. It is argued that a financial crisis is transmitted from the crisis country to other countries through either bilateral trade, or competition in a third market. Forbes and Rigoborn (2001) carries out an indepth discussion of the mixed impacts of trade links. The effect of a trade link is separated into three parts; the competitiveness effect, the income effect, and the cheap import impact.

Trade links can explain contagion because of the possibility of competitive devaluations. If the

devaluation occurs in a trading partner, or trade competitor country, the government may attempt to safeguard the country's competitiveness by devaluing its currency. Investors may foresee this problem, or assume that it will not actually happen, then change the weighting of their investment portfolio. This weighting change will directly affect the performance of domestic stock indices, therefore triggering a crash.

The income effect is referred to as the situation during the financial crisis period. For example, a country will demand less imports from other countries as public wealth declines, with those countries highly dependent on exports to the crisis country suffering consequent loss. The 2008 American crisis is a good example, as the US purchases exports from most countries around the world.

The cheap import impact is suggested to be a positive impact brought by a financial crisis, as crisis countries' governments devaluing their currencies means that it is cheaper than before the crisis for other countries to buy products and services from the crisis country.

Overall, trade link plays an import role in contagion and might transmit the crisis in various ways. In the globalised economy, it is not surprising that trade link is argued to be a highly significant factor. Khan, Wong and Yeo (2005) present more detailed work regarding the relation of trade and the contagion effect, and further confirm its importance for all four crises they test. Thus, in this study in is included as a testing channel.

2) Neighbourhood Effect

The neighbourhood effect is also as widely discussed an issue as the spillover mechanism. The neighbourhood effect can also be referred to as the regional effect. As we have seen, most crises only happen within a specific geographic region, such as in the case of the 1997 Asian crisis, and for most crises, including those that spread globally, the impact first shows in neighbourhood countries. The 2008 American crisis is of this kind.

It has been proven in previous studies to be a statistically important factor in driving the contagion effect. Despite the statistical results, theoretically, this can be explained by many other factors. First, neighbouring countries usually have closer trade, or financial, links. This is easy to understand through the effects discussed earlier, often occurring because of the absence of time difference issues and long physical distances. This means that the information of a crisis happening in a neighbouring country is usually reflected quickly.

Second, neighbouring countries usually have similar economic fundamentals which include interest rates, inflation rates, and currencies. For example, no one in the Euro zone will want to use the currency if a currency crisis in the Euro is triggered.

Furthermore, the institutional arrangements of a country or region are another important factor. Many regional and country-pairs have economic and financial organisations working together to ensure development for all of the parties involved.

The neighbourhood effect is often an important factor in economic studies, so it is included here as the second contagion channel.

3) Country Size

The term country size, used in this study, does not refer to the physical size of a country, but to its economic size. In other words, a country with relatively greater economic importance will be regarded in our analysis as a bigger country rather than one with less economic importance. There are many different benchmarks in economic terms that can be used to measure a single country's economy. For example, GDP and GDP per capita are two totally different benchmarks in measuring a country's economic size in countries such as China. As each country is assessed on a broader level regarding its productive power, the custom will be followed to measure a country's economic size by its annual GDP.

Larger countries usually play a more important role in the international stage, accounting for more productivity in the global market. Calvo and Reinhart (1996), among others, present evidence that developments in larger countries have a higher impact on smaller ones, and vice-versa. When larger countries suffer a crisis, this means a greater threat to productivity in absolute value comapre to the case that smaller countries suffer crises. A good example can be seen in a cross-crisis comparison of the recent financial crisis, with the 2008 American crisis being claimed to be the worst crisis since the Great Depression of the 1930s, with its impact

being much larger than those crises originating in emerging countries, such as the 1997 Asian crisis, which originated in Thailand.

When testing the contagion effect, quite often researchers separate their sample into two groups; developed countries, and emerging countries. It is found that emerging economies face more serious contagion risk in financial crises. From another point of view, most emerging economies do not have the same importance as developed countries in terms of economy size, which makes country size be one contagion channel in the testing.

Methodology

In this research, we follow the methodology of Hernandez and Valdes (2001) and de Gregorio and Valdes (2001). The model is designed to reflect, for a specific sample country during the crisis period, the aggregated impact of the current crisis from the other countries in the sample. The stock market returns is utilized to construct the contagion indicator while the origine of the impact is free from discussion; that is, the origin of the crisis and the relation between the origin country and the sample country is exluded. But instead, the point of view of a specific country is the focue which has already suffered from the crisis due to a contagion effect. To achieve the above, it should be figured out which of the three contagion effects tested here (trade link, the neighbourhood effect, and country size) is the most important cause of the crisis for that particular country.

The research methodology used here can be organised into three steps. In the first step, for each single crisis, we run regressions, including each chosen contagion channel, individually in order to confirm their relevance in explaining the contagion effect, as well as to compare their importance briefly. Second, by including two contagion channels simultaneously in the regression, we further compare and confirm the relative importance of the three contagion channels. In the last step, we attempt to eliminate the common shock effect.

The contagion effect of crises occurring in other countries on a particular sample country will be measured by:

$$X_{i,t} = \beta_0 + \beta_1 \sum_j m_{i,j} X_{j,t} + \xi_{i,t} \quad (1)$$

- $X_{i,t}$ measures the return on a selected domestic stock market index for country i during time t, where i represents the sample country examined;
- $X_{j,t}$ measures the return on a selected foreign stock market index for country j during time t, where j represents a group of selected foreign countries, i.e. the other countries in the sample;
- $m_{i,j}$ represents a set of weights that add up to one, each set reflecting the importance of country j for country i regarding a particular contagion channel; and
- $\xi_{i,t}$ is a stochastic shock.

In this model, the row vectors with entries $m_{i,j}$ can be stacked to form a matrix M of weights, then β_1 is evaluated for a given set of weights M varying when the regression is run to test the importance of the different contagion channels. Contagion exists where the coefficient β_1 is different from zero. This also provides statistical evidence to indicate whether the contagion channel tested is relevant in terms of the theoretical background.

Next, the size of the β_1 is compared, as differently weighted Matrices M captures the other countries' impact on a particular sample country through a contagion channel. The associated β_1, thus, reflects a weighted average effect of the crisis generated by this particular contagion channel in other countries, on this representative sample country. Also, for each crisis, when a comparison id made amongthe regression results from the individually run regressions regarding the three contagion channels, a larger value of β_1 simply indicates that the corresponding contagion channel is more important.

Likewise, the importance of different contagion channels is compared by running regressions that include two weighting matrices at the same time:

$$X_{i,t} = \beta_0 + \beta_1 \sum_j m_{i,j} X_{j,t} + \beta_2 \sum_j m'_{i,j} X_{j,t} + \xi_{i,t} \quad (2)$$

where m and m' are two sets of weights associated with two different contagion channels. We can also compare the size and significance of β_1 and β_2 here in order to confirm the results from the two models, thus generating more reliable conclusions.

Hernandez and Valdes (2001) find, however, that the coefficients may be biased, due to the simultaneous equation problem. Despite this concern, in this study this issue is neglected, since the positive bias is proportional to the coefficients. Also, if the coefficient is zero, the contagion channel is not relevant, as the bias is also zero. The comparison across betas is, therefore, still valid.

As mentioned earlier in this paper, most definitions of contagion emphasize that the contagion effect should be separated from the impact of common shocks,

which all countries suffer from at the same time. We also attempt to control common shocks by adding another variable to the model (Z_t).

$$X_{i,t} = \beta_0 + \beta_1 \sum_j m_{i,j} X_{j,t} + \beta_3 Z_t + \xi_{i,t} \quad (3)$$

Following Hernandez and Valdes (2001), we use a US stock market index return to measure the common shock as the openness and significance of the US economy, however, the corresponding NASDAQ return is regarded as Z_t in our regression, rather than the S&P 500, as it is already included in the data set. Then the existence of common shocks is investigated by means of analysis on the significance of β_3.

Sample and Data

Four crises are selected for study; the 1997 Asian crisis, the 1998 Russian crisis, the 1999 Brazilian crisis, and the 2008 American crisis. For each crisis, the sample period covers three-months, beginning with each crisis (July, August, and September 1997 for the Asian crisis, August, September, and October 1998 for the Russian crisis, January, February, and March 1999 for the Brazilian crisis, and September, October, and November 2008 for the American crisis).

The sample includes 21 countries from the 4 different regions where the four crises started; Western Europe (Euro area), America, Asia, and Russia and Eastern Europe. The countries chosen include both developed, and emerging, economies of different economic size.

For the 21 sample countries, weekly returns for the representative stock exchange indices in each country are collected for the three month span as the indicator of contagion effect. This totals 13 weeks of weekly return data for each crisis.

Weekly stock indices data is obtained from DataStream and Global Financial Database. During the crisis periods, the stock market is highly volatile. Government measures and other regulatory factors may affect the daily stock market data too greatly for it to reflect the true information. Also, the monthly data may not be enough to capture the shock. Thus, we use weekly data for this study.

Weighting Matrices

For each contagion channel, we build a weighting matrix to capture the varying relations between each pair of countries within the sample. A description of the data and the technique are applied to build the matrices as follows.

The country pair wise import and export data obtained from the Comtrade database to build the trade link matrices are the annual figures of the crisis years (i.e. 1997, 1998, 1999, and 2008)and measured in US dollars, using the sum of the import and export figures to build the matrices. Because the import and export data between Singapore and Indonesia during 1997, 1998, and 1999 crises are missing, we exclude Indonesia rather than Singapore from the study for the three crises, as Singapore is relatively more important than Indonesia as a financial market. Singapore's stock market reflects information more quickly and efficiently than that of Indonesia, especially during crisis periods when the volume of information sharply increases. Despite Singapore's economic size not as big as Indonesia's, its stock market attracts a greater amount of attention from foreign investors. Additionally, for the 2008 crisis, the import and export data for Peru in terms of all of the countries are missing, thus Peru is excluded from the sample for this crisis.

Thus, the weighting matrices for trade link will be 20*20 matrices, as only 20 countries are included from the original sample, due to data availability problems. This means that, for all four crises and over the 13 week sample periods, we have 260 observations for each crisis. Weighting matrices for the other two contagion channels also need to be adjusted to 20*20 matrices.

Neighbourhood matrices will be used to measure the physical distance impact, as already discussed. Countries from different regions can be distinguished by assigning dummy variables. Countries from the same region as the sample country tested will be assigned as a dummy variable equal to 1, and all others equal to 0.

Annual GDP data are used to measure the countries' economic size. We use the GDP data prior to each crisis year (i.e. 1996, 1997, 1998, and 2007) to build the matrices to reflect the country size impact. However, the data from the crisis year itself is not utilized as this may be greatly affected by the crisis and fail to reflect the relation between countries at the moment when the crisis is actually spread through contagion. We use the annual GDP share of the world total based on PPP data from the IMF data base, rather than the real GDP value. First, this will eliminate effects from other factors such as exchange rates and inflation. Second, when the matrices is built, country j's GDP is divided into country i's GDP in order to reflect the country size effect specific to the sample country suffering the contagion. If there is any contagion found, the focus is

on the relative importance rather than absolute importance. The GDP share of the world total based on the PPP data provides a more straightforward comparison.

Using individual weighting matrices for trade link, neighbourhood effect, and country size for each crisis, we then rescale them so that the rows add up to one. This step is required to allow for valid comparisons across crises. It also facilitates the interpretation of results in terms of the effects read as average country shocks. Again, the focus is put on relative importance rather than the magnitude of the absolute values. The neighbourhood matrices are symmetric, while the trade link and country size matrices are not. This is because neighbourhood relations between two sample countries are fixed and equal. In the case of trade link and country size, however, the relation is not equal. That is, what country A exports to country B may be not necessarily equal to what country B imports from country A, as these statistics depend on the statistical recording technique and trade system the two countries use, as well as due to some economic factors, such as the currency exchange rates. In the case of larger economies, the impact from smaller economies is not generally as big as the impact on these smaller economies. When building matrices, another important adjustment made to all of the matrices is that all entries of the diagonals should be of value zero. As other countries' impacts on the sample country are assessed, this should not include the country under study itself.

Empirical Results

A pooled OLS regression is used instead of the fixed effects, as in this regression the constant term represents the average shock received by each sample country. If we use fixed effects, we will encounter interpretation problems regarding the results, as this technique allows different constant terms for each cross-section. Also, as the four crises we test occur at different times, we are not interested in testing and comparing the results in any given time period. Thus, a pooled OLS technique is the most appropriate. To correct the possible heteroskedasticity, the robust command is added to conduct the White test. Also F-statistics and R square values are reported to indicate the overall fit of our models.

The three contagion channels; trade links, neighbourhood effects, and country size; are chosen through the examination of the existing literature. They have been found to be relevant in explaining the transmission of crises using a number of different techniques. It is expected that the betas to all be significant could be discovered, meaning that the all three factors are expected to have explanatory power for the contagion effect.

TABLE 1 IMPACT OF COMMON SHOCKS DURING CRISIS

	Trade Link	Neighbourhood Effects	Country Size
1997 Asian Crisis			
Coefficient of Contagion Channel	0.5347***	0.6731***	0.5563***
t	*(3.63)*	*(3.93)*	*(3.89)*
Coefficient of Common Shock	0.2251	0.2411	0.1501
t	*(0.33)*	*(0.35)*	*(0.21)*
Constant	0.0092	0.0094	0.0095
t	*(1.38)*	*(1.57)*	*(1.43)*
F-Statistics	8.22	8.49	9.35
Prob>F	*0.0077*	*0.0070*	*0.0051*
R^2	0.4492	0.4685	0.4393
1998 Russian Crisis			
Coefficient of Contagion Channel	0.4548***	0.6313***	0.4229***
t	*(7.33)*	*(5.57)*	*(4.34)*
Coefficient of Common Shock	0.0687	0.0943	0.1136
t	*(0.86)*	*(0.85)*	*(0.89)*
Constant	0.0019	0.0034	-0.0004
t	*(0.52)*	*(0.80)*	*(-0.08)*
F-Statistics	37.88	141.63	23.57
Prob>F	*0.0000*	*0.0000*	*0.0002*
R^2	0.8524	0.8715	0.7671
1999 Brazilian Crisis			
Coefficient of Contagion Channel	0.4858***	1.365***	0.4901***
t	*(5.16)*	*(4.15)*	*(3.41)*
Coefficient of Common Shock	-0.0306	-0.0376	0.0016
t	*(-0.44)*	*(-0.18)*	*(0.02)*
Constant	0.0006	0.0056	0.0004
t	*(0.15)*	*(1.06)*	*(0.09)*
F-Statistics	13.66	18.03	5.86
Prob>F	*0.0014*	*0.0005*	*0.0207*
R^2	0.5444	0.7361	0.4600
2008 American Crisis			
Coefficient of Contagion Channel	1.083***	1.034***	0.8294***
t	*(3.93)*	*(10.21)*	*(3.04)*
Coefficient of Common Shock	-0.0278	-0.0259	0.0984
t	*(-0.09)*	*(-0.19)*	*(0.33)*
Constant	0.0137	0.0098	0.0131
t	*(1.78)*	*(1.96)*	*(1.61)*
F-Statistics	80.17	296.95	46.24
Prob>F	*0.0000*	*0.0000*	*0.0000*
R^2	0.9119	0.9789	0.8776

This table reports the results from the pooled regressions where the independent variables are each of the contagion channel measures and the common shock measure. Significance at the 1%, 5%, and 10% level (based on standard errors that are robust for heteroskedasticity) is indicated by ***, ** and * respectively.

First, it is found that the common shock factors are not statistically significant in any of the regressions. This finding fits the theoretical definition of contagion as discussed in earlier sections, and allows us to continue further in our study. The regression results from testing the impact of common shocks are presented in Table 1.

TABLE 2 UNIVARIANT TEST OF CONTAGION CHANNELS

	Trade Link	Neighbourhood Effects	Country Size
	1997 Asian Crisis		
Coefficient of Contagion Channel	0.2750***	0.7095***	0.2059***
t	*(4.62)*	*(8.49)*	*(3.94)*
Constant	0.0007	0.0003	0.0007
t	*(0.26)*	*(0.12)*	*(0.28)*
F-Statistics	21.32	72.16	15.54
Prob>F	*0.0000*	*0.0000*	*0.0001*
R^2	0.0727	0.2620	0.0483
	1998 Russian Crisis		
Coefficient of Contagion Channel	0.2513***	0.7865***	0.0198***
t	*(5.64)*	*(11.32)*	*(4.52)*
Constant	-0.0062	-0.0018	-0.0066
t	*(-1.38)*	*(-0.47)*	*(-1.45)*
F-Statistics	31.83	128.07	20.44
Prob>F	*0.0000*	*0.0000*	*0.0000*
R^2	0.0874	0.4016	0.0618
	1999 Brazilian Crisis		
Coefficient of Contagion Channel	0.2079***	0.6552***	0.1666***
t	*(4.30)*	*(6.82)*	*(3.69)*
Constant	0.0043	0.0019	0.0045
t	*(1.58)*	*(0.77)*	*(1.65)*
F-Statistics	18.47	46.48	13.64
Prob>F	*0.0000*	*0.0000*	*0.0003*
R^2	0.0361	0.2235	0.0264
	2008 American Crisis		
Coefficient of Contagion Channel	0.4271***	0.9223***	0.2771***
t	*(6.18)*	*(17.91)*	*(4.36)*
Constant	-0.0158***	-0.0021	-0.0200***
t	*(-3.22)*	*(-0.58)*	*(-3.87)*
F-Statistics	38.16	320.90	19.00
Prob>F	*0.0000*	*0.0000*	*0.0000*
R^2	0.3165	0.7075	0.2053

This table reports the results from the pooled regressions where the independent variables are each of the contagion channel measures. Significance at the 1%, 5%, and 10% level (based on standard errors that are robust for heteroskedasticity) is indicated by ***, ** and * respectively.

Furthermore, for regressions containing only single transmission channels, the finding is as expected. In all four crises, the coefficients of trade link, neighbourhood effects, and country size are all positive, statistically significantly different from zero. In other words, the contagion effect exists, with all three channels accounting for the spillover of the financial crises. When we compare the betas of each contagion channel, the results are highly consistent across each crisis. The neighbourhood effect tends to be the dominant contagion channel over the other two channels, with trade link the second most important channel, however, the importance of trade link is not significantly higher than that of country size.

On examining each individual crisis, the 2008 American crisis is found to have the highest betas over the other three crises for all three contagion channels. This strongly suggests that the 2008 crisis is the most contagious financial crisis, which is consistent with the suggestion of former studies that, when a developed country suffers a financial crisis, the impact tends to be bigger than the case when the crisis originates from emerging economies. It is not surprising that the 2008 crisis in the US has been proven to be the worst financial crisis of the four crises under study. The regression results from the single factor model is presented in Table 2.

Table 3 provides the results from our examination of the importance of contagion channels, by conducing regressions containing two contagion channels at the same time. Again, the finding is highly consistent across the four crises. This further confirms the result of the first single factor model that the neighbourhood effect is the most dominant transmission channel. When we include country size and neighbourhood effect, or trade link and neighbourhood effect, simultaneously for testing, these two contagion channels lose their statistical importance, however, they do have a positive impact in driving the contagion effect.

An interesting finding of the two factor model is that, when we include country size and trade link together, for the 1997 Asian crisis, the 1998 Russian crisis, and the 1999 Brazilian crisis, the betas of trade link are statistically significant. Meanwhile, the country size factor is insignificant, however, for the 2008 American crisis, both trade link and country size effect are statistically important, although trade link remains a more important driver than country size when we compare the magnitude of the betas. Another noticeable phenomenon is that the betas of country size become negative when trade link is included in the regression for the 1997 Asian crisis, the 1998 Russian crisis, and the 2008 American crisis. This may be explained by the correlation between trade link and country size, as a country with higher GDP tends to have a higher trade balance.

TABLE 3 SIMULTANEOUS TESTS ON CONTAGION CHANNELS

Contagion Channel One	**Trade Link**	**Trade Link**	**Neighbourhood Effects**
Contagion Channel Two	**Neighbourhood Effects**	**Country Size**	**Country Size**
	1997 Asian Crisis		
Coefficient of Contagion Channel One	0.0223	0.4837***	0.6920***
t	*(0.58)*	*(2.81)*	*(7.74)*
Coefficient of Contagion Channel Two	0.6945***	-0.2065	0.0319
t	*(7.25)*	*(-1.32)*	*(1.05)*
Constant	0.0003	0.0007	0.0003
t	*(0.11)*	*(0.26)*	*(0.11)*
F-Statistics	42.50	14.06	40.41
Prob>F	*0.0000*	*0.0000*	*0.0000*
R^2	0.2623	0.0794	0.2630
	1998 Russian Crisis		
Coefficient of Contagion Channel One	0.0095	0.4201	0.7843
t	*(0.32)*	*(3.39)*	*(10.31)*
Coefficient of Contagion Channel Two	0.7802***	-0.1693	0.0036
t	*(9.88)*	*(-1.43)*	*(0.14)*
Constant	-0.0017	-0.0062	-0.0017
t	*(-0.46)*	*(-1.38)*	*(-0.47)*
F-Statistics	76.07	21.30	71.03
Prob>F	*0.0000*	*0.0000*	*0.0000*
R^2	0.4017	0.0932	0.4016
	1999 Brazilian Crisis		
Coefficient of Contagion Channel One	0.0011	0.2028	0.6429
t	*(0.02)*	*(2.40)*	*(6.39)*
Coefficient of Contagion Channel Two	0.6546***	0.0057	0.0322
t	*(6.24)*	*(0.08)*	*(0.77)*
Constant	0.0019	0.0043	0.0018
t	*(0.77)*	*(1.57)*	*(0.73)*
F-Statistics	24.68	9.39	24.81
Prob>F	*0.0000*	*0.0001*	*0.0000*
R^2	0.2235	0.0361	0.2244
	2008 American Crisis		
Coefficient of Contagion Channel One	0.0590**	0.7929***	0.8907***
t	*(1.96)*	*(5.29)*	*(15.46)*
Coefficient of Contagion Channel Two	0.8702***	-0.3167***	0.0364*
t	*(13.67)*	*(-2.71)*	*(1.63)*
Constant	-0.0020	-0.0145***	-0.0020
t	*(-0.54)*	*(-2.97)*	*(-0.55)*
F-Statistics	198.11	34.99	179.83
Prob>F	*0.0000*	*0.0000*	*0.0000*
R^2	0.7112	0.3528	0.7102

This table reports the results from the pooled regressions where the independent variables are combinations of any two of contagion channel measures. Significance at the 1%, 5%, and 10% level (based on standard errors that are robust for heteroskedasticity) is indicated by ***, ** and * respectively.

Concludeing Remarks

In this study, by reviewing the existing literature in this field; and discuss on the turmoil phenomenon during financial crisis periods; we follow the definition of contagion as the co-movement of financial markets during the crisis period after eliminating the common shock impact. The stock market is regarded as our indicator of the contagion effect and the 1997 Asian crisis, the 1998 Russian crisis, the 1999 Brazilian crisis, and the most recent crisis, the 2008 American crisis have been studied. The returns from major stock indices in 21 countries which vary greatly in terms of economic fundamentals, are tested over three contagion channels (trade link, neighbourhood effect, and country size). These contagion channels are selected on the basis of prior studies. The relatively most important channels has been determined, in addition, whether this importance is equal across different crises is examined as well.

Our model consists of three steps. In the first step the existence of contagionhas been tested to confirm the relevance of the chosen contagion channels, and the comparisons is made across the contagion channels as well as the four crises. Afterward, by inclusion of two contagion channels at the same time, their importances are further verified, while the relation among three transmission channels is examined as well. In the last step, it has been proved that our results are free from the impact of common shock, in order to satisfy the theoretical constraint.

Our findings agree with most former studies, with the three chosen transmission channels found to have explanatory power in all of the crises examined. Over these four crises, the neighbourhood effect is found to be the strongest factor driving the crises, followed by trade link which does not have a significant advantage over country size. This may explain why most financial crises tend to be regional. The 2008 financial crisis is found to be the most contagious of those examined, with common shocks not found to be significant in our analysis.

It is apparent that each crisis is subjected to different characteristics and varying conditions, however, our findings still find some commonalities among them. By knowing the importance of contagions, and the strongest contagions, policymakers can take more

appropriate measures to prevent the occurrence of contagions. If contagions still occur, the appropriate actions will be able to be taken, and investors will have more accurate expectations, which may lead to a more widely diversified investment portfolio.

This study does have some limitations, such as, the lack of a discussion on the definition of contagion and on the limitation of study only on the relative importance, but not the precise measurement of the magnitude of the contagions; as well as the missing of other possible transmission channels beside the three selected, and the impact of the contagion effect vary in other financial markets. These limitations should be addressed in future study of this topic.

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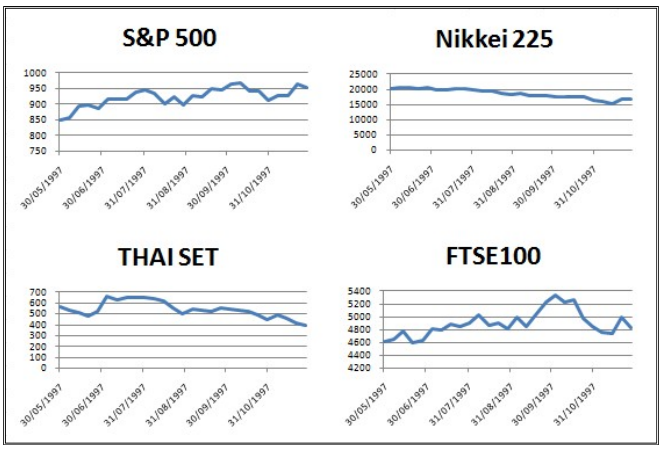
Appendix

1997 Asian Crisis



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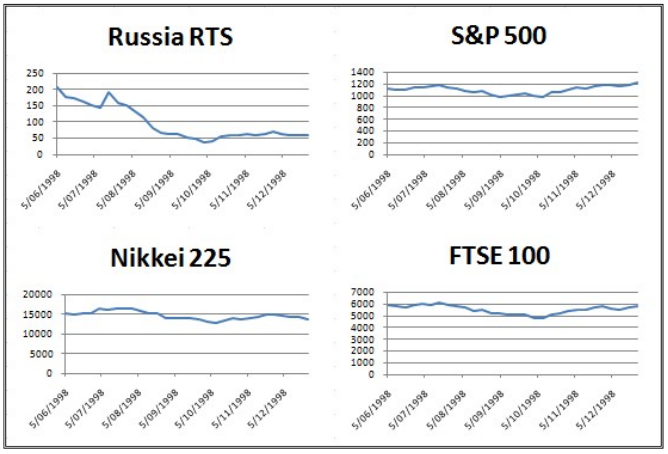

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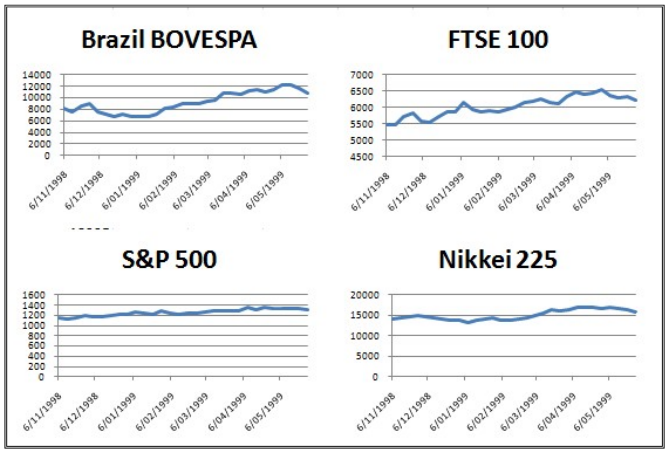
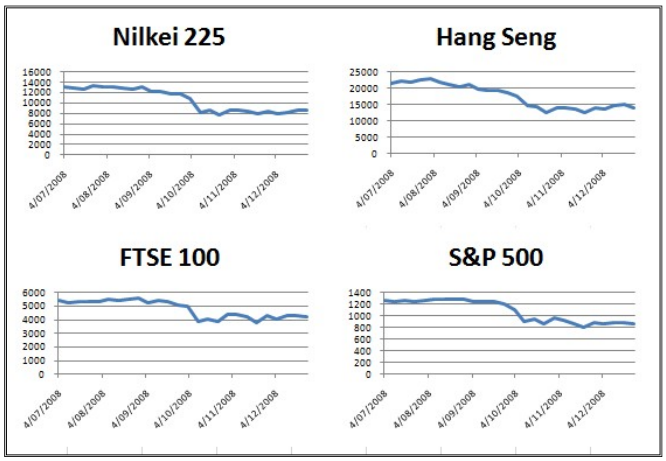


2008 American Crisis



Appendix A: Major Stock Indices Performance during Crises Periods